

**Araştırma\***

## Conceptual Level of Understanding about Sound Concept: Sample of Fifth Grade Students

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### Abstract

In this study, students' conceptual change processes related to the sound concept were examined. Study group was comprises of 325 fifth grade middle school students. Three multiple-choice questions were used as the data collection tool. At the data analysis process "scientific response", "scientifically unacceptable response" and "no response" categories were used. While about the concept of sound before instruction scientific answer rate was very low, after instruction the rate of misconceptions has decreased. At students "the sound is not spread in solid and liquid phase" and "sound spread velocity does not depend on the phase" misconceptions were encountered. After instruction students' scientific answer rate has been increased. Experimental based instruction process has been effective in changing students' ideas about the concept of sound. Different studies can be done for investigating in this age group students' ideas about the concept of sound.

Keywords: Conceptual level, sound concept, middle school students

### INTRODUCTION

In the last thirty years, studies have been carried out in science education in order to determine the student's thoughts on science concepts and these studies revealed many misconceptions among students on the relevant issues. Hewson and Hewson (1983) define misconception as concepts that the students maintain even after education, and which do not comply with scientific knowledge. Although many studies that identify misconceptions have been carried out, the number of studies aimed at changing the students' thoughts on these misconceptions is less. The conceptual change theories of Posner, Strike, Hewson and Gertzog (1982) form the basis of conceptual change. In this theory, they argue that initially the student should feel dissatisfied with his/her current idea, and then should respectively find the new concept intelligible, plausible and fruitful in order to achieve the conceptual change. They indicate that the conceptual change cannot be achieved if the student does not accept these three conditions on the newly learned concept. This theory is criticized by Pintrich, Marx and Boyle (1993) as it ignores students' in-class attitudes. Pintrich and others indicate that one should consider the students' motivational states in

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order to achieve conceptual change. Vosniadou (1994) classifies students' ideas under three groups; beginning, synthesis and scientific. According to Vosniadou, students' ideas in beginning and synthesis groups should change towards scientific knowledge in order to achieve conceptual change. Vosniadou and Ioannides (1998) argue that conceptual change can be achieved in two ways. The first one is the conceptual change that occurs spontaneously. Here, students' ideas can grow towards scientific knowledge without any interference. The second one is instruction based conceptual change and this conceptual change needs teaching to change the students' ideas towards scientific knowledge. As misconceptions generally have resistance to change, education where various conceptual change methods are utilized can be effective in changing the students' ideas. Many conceptual change strategies such as texts on conceptual change (Balçı, Çakıroğlu & Tekkaya, 2005; Guzzetti, Synder and Glass; 1992), cognitive conflict (Limón, 2001, Caravita, 2001), analogies (Bilgin & Geban, 2001), cooperative learning methods (Mason, 2001), 5E learning model (Campbell, 2006; Ceylan & Geban, 2009) are used to change the students' ideas to scientific knowledge.

#### Studies on the Sound Concept

There are studies that investigate the ideas of students from different educational levels on the sound concept. The results obtained from these studies are briefly mentioned below. Atasoy, Tekbıyık and Gülay (2013) researched the effect of concept cartoons on the ideas of students from the fifth grade of middle school about the sound concept. They determined that using concept cartoons in teaching the sound concept increased the success of students after education. Bolat and Sözen (2012) researched the ideas of middle school students on the speed of sound and determined that they have various prejudiced ideas about the speed of sound. The encountered misconceptions include the ideas that argue the sound spreads faster in emptiness, that the sound does not spread in solid environment, that the increase in temperature decelerates the speed of sound, that the speed of sound increases as the clearance increase between grains of the environment where the sound spreads. Çalık, Okur and Taylor (2011) compared the ideas of students in a class where texts on conceptual change, animations and analogies are used in the fifth grade of middle school with the ideas of students in the class where conventional teaching methods are used in terms of sound propagation. The students in groups where conceptual change methods are used are found more successful on sound propagation than those of conventional teaching methods. Demirci and Efe (2007) found out in their study aimed at identifying the misconceptions of middle school fifth grade students on the subject of sound, that the students have many misconceptions on the sound concept. The students' answers include misconceptions such as; "sound propagates in air-free environment and stops by striking an obstruction", "sound is formed by the molecules' reflecting from a surface", "sound is formed by the clash of vocal cords", "sound moves faster if it does not encounter any object in the air" and "sound propagates faster as the density of solid objects is less". Gölgeci and Saraçoğlu (2011) researched the effect of using concept cartoons on the middle school sixth grade students in learning the concept of sound. The results of this study

revealed that using concept cartoons are effective on teaching the concept of sound. Mazens and Lautrey (2003) researched the conceptual change processes of eighty nine students from primary school, ranging in age from six to ten, in terms of sound concept. This study encountered misconceptions before education such as thinking that the sound passes through holes, that sound cannot pass through nonpermeable environments. The frequency of encountering these misconceptions decreased after instruction. Okur (2009) compared a middle school fifth-grade class where conventional teaching methods are used to a class where conceptual change texts, analogy-aided 4E learning model and 5E model are used. The classes where conceptual change methods are used are more successful than those that use conventional teaching methods. The success level on sound propagation is at its highest in the class where 5E learning model is used. Pektaş, Çelik, Katrancı and Köse (2009) and Salgut (2007) researched the effects of computer-aided instruction on the ideas of primary education students from fifth grade about the concept of sound. The results of these two studies revealed that computer-aided instruction is more effective on the students' ideas on the concept of sound than the conventional instruction method.

Tok (2008) indicated that reflective thinking activities are more effective than conventional instruction methods on the ideas of middle school fifth-grade students about the concept of sound. In this study, the students in the group where reflective thinking activities are used state after education that every substance produces sound, that sound creates environmental pollution, and that sound is transferred between molecules. There are studies that examined the ideas of teacher candidates on the sound concept, instead of middle school students. In one of these studies, Küçüközer (2009) researched the ideas of science teachers on the subjects of sound propagation, nature of sound and the speed of sound propagation. The results of this study revealed that teacher candidates have misconceptions such as considering sound as an entity, thinking that sound can propagate in emptiness, and that the movement of surrounding particles is irregular while the sound propagates. Öztürk and Atalay (2012) encountered misconceptions in their studies where they examined misconceptions of science teacher and class teacher candidates on the concept of sound, such as thinking that sound propagates by passing through emptiness, that the sound transmission is dependent on the thickness of the wall, that the strength of the sound source is effective on the transmission of sound. These studies revealed many misconceptions in middle school students and teacher candidates about the concept of sound. It is determined that computer-aided instruction, using analogy, animations, conceptual change texts or concept cartoons are effective on the ideas of middle school students about the concept of sound. It is concluded that the effects of conventional teaching is less effective on changing the misconceptions of students about the concept of sound than student-centered teaching methods. The purpose of this study is determined by starting from this fact.

#### Purpose of the Research

Studies have been carried out in the literature that research the ideas of middle school students on the concept of sound and where different teaching methods are

used for example, computer-aided instruction methods and concept cartoons in particular. This study aims to research the effects of experiment-based teaching on the ideas of middle school fifth grade students on the concept of sound. To this aim, fifth grade students' ideas related to sound concept reveal and compared before and after experiment-based teaching.

## METHOD

Single group pretest-posttest design, which is a weak experimental research design, is used in this research. This study consists of three stages; pre-experimental, experimental process and post-experimental. In the weak experimental research design, the pretest is applied to the research group, then the experimental study is performed on the research group and finally the posttest is applied to the same group (Cohen, Manion & Morrison, 2005). In this research design, the effect of experimental study on the difference between pretest and posttest is analyzed.

### Study Group

The research group of this study consists of three hundred twenty five (one hundred and sixty nine girls, one hundred fifty six boys) middle school 5th grade students. These students are from twelve fifth grade classes in two middle schools which are at the city center in the west side of Turkey. These twelve classes are instructed by four different science teachers. These students received education on the concept of sound in the relevant course unit in Science lessons of third and fourth grade in elementary school, and they have prior knowledge about the concept of sound.

### Data Collection Tool

A conceptual understanding test that consists of three questions is developed by the researcher to identify the ideas of fifth grade students on the concept of sound. The questions in the conceptual understanding test are multiple-choice and consist of four choices. Students are required to explain their ideas on the answers they give to every question.

The first question in the conceptual understanding test is taken from the study by Demirci and Efe (2007) which aimed to identify the ideas of elementary school students on the subject of sound. The second and third questions are developed by the researcher, considering the course acquisitions. The first question is about sound propagation in airless environments, the second one is about the environments where the sound propagates and the third one is about the sound coming from different sound sources.

The conceptual understanding test is examined by two science teachers and corrected according to their opinions. The reliability study of the edited conceptual understanding test is performed with sixty students from fifth-grade in a different middle school. The reliability co-efficient of the test, which is cronbach's  $\alpha$  co-efficient, is calculated as .783. The usability of the test is considered adequate as this reliability co-efficient is above .70 (Büyüköztürk, 2010).

## Data Analysis

The analysis of the students' answers to the questions in conceptual understanding test is performed with descriptive analysis. Three assessment categories are used in analyzing the students' answers. These categories are; "scientific response", "scientifically unacceptable response" and "no response". "Scientifically unacceptable response" answer category includes misconceptions about the subject. Students' answers are categorized and then the frequency of their partaking in these categories is calculated.

## Period of Instruction

Six hours of experiment-based instruction is performed in every class for the acquisitions in the sound unit. The science lectures on this unit are given by teachers in the science laboratory of the school. Before the lesson, four science teachers are informed about the purpose and process of the experiments and the preparation procedure of these experiments are explained step by step.

In all classes, experiments are carried out regarding sound propagation, whether sound can propagate in airless/liquid environments, sound transmission, sound produced by different objects and sound being heard differently in different environments. These experiments take place at the fifth grade science textbook. These experiments aimed at making the students comprehend the effects of the environment on sound propagation. The laboratory environment is arranged according to a student centered pattern so that all students can participate in the experiment process. The aim of experiment-based instruction method is to make the students gain scientific knowledge on sound propagation.

## FINDINGS

The findings that are obtained from analyzing the questions in sound concept are as follows in Table 1, Table 2 and Table 3.

**Table 1.**

*The Findings Obtained From Analysis of First Question Before and After Instruction*

Response categories	Before instruction	After instruction
	n (%)	n (%)
Scientific response	91 (28)	217 (66,8)
Scientifically unacceptable response	228 (70,2)	100 (30,8)
No response	6 (1,8)	8 (2,4)

Before instruction, 28% of the students chose the correct answer in the question about the propagation of sound in emptiness. However, these students could not use scientific expressions in explaining their answers. After instruction, 66.8% of students chose the correct answer and indicated that sound does not propagate in emptiness when explaining their answers. Before instruction, 70.2% of students gave scientifically unacceptable responses. The most common misconception among students about this concept is the thought of sound propagating in emptiness and the

frequency of encountering this misconception decreases after education. Six students do not answer the question before instruction, while eight students could not answer after instruction.

**Table 2.***The Findings Obtained From Analysis of Second Question Before and After Instruction*

Response categories	Before instruction	After instruction
	n (%)	n (%)
Scientific response	162 (49,8)	259 (79,7)
Scientifically unacceptable response	159 (48,9)	55 (16,9)
No response	4 (1,2)	11 (3,4)

Before instruction, 49.8% of students indicated that sound does not propagate in emptiness on the question about environments where sound does not propagate. The percentage of correct answers is 79.7% after instruction. Nearly half of the students before instruction gave the scientific answer that says sound does not propagate in emptiness. 48.9% of students' answers before instruction do not comply with scientific answers. Eighteen of students who gave scientifically unacceptable answers indicated that sound does not propagate in planes, seventy seven of them said sound does not propagate in sea (in liquid environments) and sixty-four of them said sound does not propagate in rocks (solid environments). The frequency of encountering non-scientific answers after instruction is decreased to 16.9%. The students' misconception about the environments where sound does not propagate is reduced after education. Eight students have the misconception of thinking that sound does not propagate in planes, fifteen of them think that it does not propagate in water whereas thirty-two students think sound does not propagate in rocks. Four students did not give any opinion before instruction, whereas eleven students did not give opinion after instruction.

**Table 3.***The Findings Obtained From Analysis of Third Question Before and After Instruction*

Response categories	Before instruction	After instruction
	n (%)	n (%)
Scientific response	206 (63,4)	237 (72,9)
Scientifically unacceptable response	112 (34,5)	79 (24,3)
No response	7 (2,1)	9 (2,8)

Before instruction, 63.4% of students gave scientific answers about the fact that sounds that are produced from different sound sources are different. The percentage of students who gave scientific answers after instruction is 72.9%. There are various misconceptions in 34.5% of students about the subject before instruction, whereas this percentage is reduced to 24.3% after instruction. Before instruction, thirty-six students have the misconception that the sounds produced from musical instruments are different because they are played by different people, whereas the same misconception is encountered in twenty-two students after instruction. The

misconception of thinking that the environment where the musical instruments are played is effective on hearing the sounds differently is encountered in fifty-five students before instruction and in thirty-eight students after instruction. Finally, the misconception of thinking that sound is heard differently by different people is encountered in twenty-one students before instruction, and in nineteen students after instruction. The frequency of encountering misconceptions about this concept is decreased after instruction. Seven students did not give any opinion before instruction whereas nine students did not state their opinions after instruction.

## RESULTS AND CONCLUSIONS

As a result of this study, it is seen that experiment-based education affects the ideas of 5th grade students about the concept of sound. The frequency of scientific answers after experiment-based education is higher than the same frequency before education. Experiment-based education has an impact on students to give scientific answers and the frequency of encountering misconceptions in students after education is decreased. Çalık and others (2011), who researched the opinions of middle school students about the concept of sound, indicate that using conceptual change texts, animations and analogies have an impact on changing the students' ideas on the concept of sound, whereas Gölgeci and Saraçoğlu (2011) say the same for using concept cartoons, Okur (2009) for conceptual change texts and 5E instruction method, Pektaş and others (2009) and Salgut (2007) for computer-aided education, Tok (2008) for reflective thinking activities. Çalık and others (2011), Okur (2009) and Tok (2008) indicate in their studies that studies that use conceptual change methods are more effective than conventional education methods. Similar to the results of these studies on the concept of sound, the current study also determines that using conceptual change methods has an impact on changing the ideas of middle school students on the concept of sound towards scientific knowledge.

Demirci and Efe (2007) encountered the misconception of thinking that sound propagates in emptiness in middle school fifth-grade students, whereas Küçüközer (2009) and Öztürk and Atalay (2012) encountered the same in teacher candidates. Similar to the misconception of thinking that sound does not propagate in rocks (solid environments) in this study, Bolat and Sözen (2012) encountered the same misconception in middle school 5th grade students. The misconceptions in other questions, such as thinking that sound does not propagate in planes or in sea, that music instruments produce different sounds as they are played by different people, the environment where the music instruments are played have impact on hearing the sounds different and that sound is heard differently by different people, are encountered for the first time in this study within our knowledge.

## RECOMMENDATIONS

Conceptual change methods have an impact on changing the thoughts of middle school students on the concept of sound towards scientific knowledge. By using different methods than the conceptual change methods used in studies that research middle school students' periods of conceptual change regarding the concept of sound, conceptual change studies can be carried out on the concept of sound, studies that research the effects of experiment-based teaching not only about the concept of sound but also on different concepts in science, can be performed. In addition, studies that research the students' conceptual change processes regarding these concepts can be carried out.

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## **Ortaokul Beşinci Sınıf Öğrencilerinin Ses Kavramı ile İlgili Kavramsal Anlama Düzeyleri**

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### **Genişletilmiş Özet**

**Problem:** Ioannides (1998) kavramsal değişimin iki şekilde gerçekleşebildiğinden bahsetmektedir. Birincisi, kendiliğinden gerçekleşen kavramsal değişimdir. İkincisi, öğretim temelli kavramsal değişimdir ve bu türde öğrencilerin fikirlerinin bilimsel bilgiye doğru değişmesi için öğretime ihtiyaç duyulmaktadır. Kavram yanlışları çoğu zamanda değişime dirençli olduğu için çeşitli kavramsal değişim yöntemlerinin kullanıldığı öğretim öğrencilerin fikirlerinin değişiminde etkili olabilmektedir. Ortaokul öğrencilerinin ses kavramı ile ilgili fikirlerine bilgisayar destekli öğretimin, analogi kullanmanın, animasyonların, kavramsal değişim metinlerinin ya da kavram karikatürü kullanımının etkili olduğu belirlenmiştir. Ses kavramı ile ilgili öğrencilerde karşılaşılan kavram yanlışlarına ilişkin fikirlerin değişiminde klasik öğretimin etkisinin öğrenci merkezli öğretim yöntemlerine oranla daha az olduğu belirlenmiştir. Bu çalışmada, öğrencilerin ses kavramı ile ilgili kavramsal değişim süreçlerine deney temelli öğretimin etkisi araştırılmıştır.

**Yöntem:** Bu çalışmada, araştırma deseni olarak zayıf deneysel desenden biri olan tek grup ön-test son-test kullanılmıştır. Çalışma grubunu Türkiye'nin batı bölgesindeki bulunan iki ortaokuldaki oniki beşinci sınıfta öğrenim gören 325 5. sınıf öğrencisi oluşturmaktadır. Veri toplama aracı olarak üç adet çoktan seçmeli sorudan oluşan bir test kullanılmıştır. Testin güvenilirlik katsayısı cronbach's  $\alpha$  katsayısı .783 hesaplanmıştır. Bu test öğretim öncesi ve sonrası öğrencilere uygulanmıştır. Öğrencilerin bu sorulara verdiği cevapların analizinde "bilimsel cevaplar", "bilimsel olarak kabul edilemeyen cevaplar" ve "cevap yok" kategorilerinden oluşan rubrik kullanılmıştır. Öğretim sürecinde her sınıfta 6 saatlik deney temelli öğretim düzenlenmiştir. Bütün sınıflarda sesin yayılması ile ilgili havasız ortamda sesin yayılıp yayılmayacağını gösteren, sesin iletimi, sesin sıvı ortamda yayılması, farklı cisimlerin ürettikleri ses ve aynı sesin farklı ortamlarda duyulması ile ilgili deneyler yapılmıştır.

**Bulgular:** Ses kavramı ile öğretim öncesi öğrencilerde bilimsel cevaplar ile karşılaşılma oranı az iken, öğretimden sonra bilimsel cevaplar ile karşılaşılma oranı artmıştır. Deney temelli öğretim öğrencilerin bilimsel cevap vermesinde etkili olmuştur. Öğrencilerde öğretim öncesi olduğu gibi öğretim sonrası da "sesin katı ve sıvı ortamlarda yayılmadığı", "sesin yayılma hızı ortama bağlı değildir", "ses boşlukta yayılır" kavram yanlışları ile karşılaşmıştır. Diğer sorularda karşılaşılan sesin uçağın ve denizin içinde yayılmadığı, müzik aletlerini farklı kişiler çaldığı için farklı sesler duyulduğu, müzik aletlerinin çalındığı ortamın seslerin farklı



duyulmasında etkili olduđu ve ses farklı kişiler tarafından farklı duyulduđu kavram yanılırları ile bilgimiz dahilinde ilk kez bu çalışmada karşılaşılmıştır.

**Öneriler:** Ses kavramı ile ilgili bu yaş grubundaki öğrencilerin fikirlerini araştıran farklı öğretim yöntemlerinin kullanıldığı çalışmalar yapılabilir.

**Anahtar kelimeler:** Kavramsal anlama, ses, ortaokul öğrencileri

